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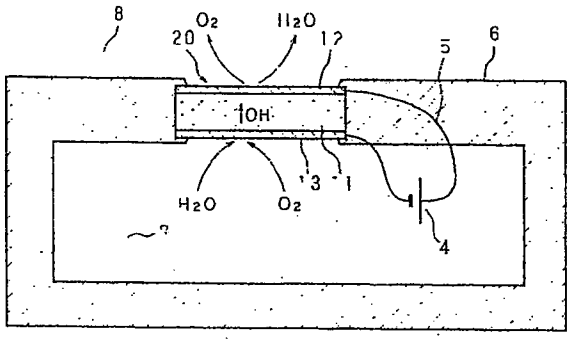
(54) **Air conditioning method and apparatus.**

(57) An air conditioning method and apparatus for electrochemically regulating humidity and oxygen-concentration within an enclosure (6) by the use of an ion exchanger polymer electrolyte. Where the humidity and the oxygen-concentration within the enclosure are to be reduced, a cell (20) comprising an anode (12), and a cathode (13) sandwiching an anion exchanger polymer electrolyte is arranged so that a surface of the anode (12) is in contact with an atmospheric air (8) outside the enclosure and a surface of the cathode (13) is in contact with an ambient atmosphere (7) inside the enclosure, and DC voltage is applied between the electrodes (12, 13). Where the humidity and the oxygen-concentration within the case are to be increased, a cell having a similar construction is arranged so that the surface of the anode is in contact with the ambient atmosphere inside the enclosure and the surface of the cathode is in contact with the atmospheric air outside the enclosure and DC voltage is applied between the electrodes.

Fig. 2



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AIR CONDITIONING METHOD AND APPARATUS

The present invention relates to an air conditioning method and apparatus for electro-chemically controlling the humidity and the oxygen-concentration within a case by the use of an ion exchanger polymer electrolyte.

The condensing method, in which a temperature is lowered to condense steam in an atmosphere, and the absorbing method, in which steam is absorbed by a desiccating agent such as silica gel, have been known for the conventional dehumidifying method. The condensing method has exhibited a problem in that it is not suitable for the use where it is not appropriate to lower a temperature while the absorbing method has exhibited a problem in that the regeneration treatment is required.

A method using an ion exchanger polymer electrolyte comprising a cat ion exchanger Polymer electrolyte (Japanese Patent Application Laid-Open No. Sho 61-216714) has been known as an air conditioning method, in particular a dehumidifying method, solving such problems.

Fig. 1 of the accompanying drawings shows a working condition of the conventional dehumidifying method disclosed in Japanese Patent Application Laid-Open No. Sho 61-216714. Referring now to Fig. 1, reference numeral 6 designates a case for an object to be dehumidified. The case 6 is provided with a cell 10 having an anode 2, a cathode 3 and a cation exchanger polymer electrolyte 1 sandwiched between both the electrodes 2, 3 so that the cell 10 extends through a wall of the case 6. A surface of the anode 2 is in contact with an ambient atmosphere 7 inside the case 6 while a surface of the cathode 3 is in contact with an atmospheric air 8. The anode 2 and the cathode 3 are connected to a DC power source 4 through lead wires 5 and DC voltage is applied between both the electrodes 2, 3 as far as hydrogen is not generated from the cathode 3.

Next, the operation is described. Steam in the ambient atmosphere 7 acts upon the anode 2 in such a manner as expressed by the following equation (1):

$$2H_2O \rightarrow O_2 + 4H^+ + 4e^- \quad (1)$$

Oxygen formed by this reaction is left in the case 6. On the other hand, hydrogen ions formed are transferred onto the cathode 3 through the cation exchanger polymer electrolyte 1 where hydrogen ions act upon oxygen in the atmosphere air 8 in such a manner as expressed by the following equation (2)

$$O_2 + 4H^+ + 4e^- \rightarrow 2H\,O \quad (2)$$

As a result, water (steam) is decomposed on ambient atmosphere 7, while water is formed on the side of the cathode 3, that is, the side of the atmospheric air 8. As a whole, the water is transferred from the ambient atmosphere 7 inside the case 6 to the atmospheric air 8 and thus the inside of the case 6 is dehumidified.

The above described air conditioning method (dehumidifying method) using the cation exchanger polymer electrolyte has exhibited the following problems:

Steam is reduced (the humidity is reduced) and the oxygen-concentration is increased on the side of the anode 2, that is, in the ambient atmosphere 7 inside the case 6, while steam is increased (the humidity is increased) and the oxygen-concentration is reduced on the side of the cathode 3, that is, on the side of the atmospheric air 8. Where it is desired to reduce both the humidity and the oxygen-concentration in order to suppress the progress of corrosion, a problem has occurred in that the above described air conditioning method using the cation exchanger polymer electrolyte can not be applied.

An object of the present invention is to solve the above-described problems.

It is an object of the present invention to provide an air conditioning method and apparatus capable of simultaneously reducing a humidity and oxygen-concentration within an enclosure.

It is another object of the present invention to provide an air conditioning method and apparatus capable of simultaneously increasing humidity and oxygen-concentration within an enclosure.

It is still another object of the present invention to provide an air conditioning method and apparatus capable of simultaneously reducing a humidity and an oxygen-concentration, thereby preventing a progress of corrosion.

It is a further object of the present invention to provide an air conditioning method and apparatus capable of simultaneously increasing a humidity and an oxygen-concentration, for application to an endurance test for corrosion of electronic instruments and the like.

Where the humidity and the oxygen-concentration within a case are reduced according to the present invention, a cell comprising an anode, a cathode and an anion exchanger polymer electrolyte sandwiched between both the electrodes so that a surface of the anode may be in contact with an atmosphere outside the case and a surface of the cathode may be in contact with an atmosphere inside the case and DC voltage is applied between both the electrodes. On the other hand, where the

case are increased according to the present invention, a cell having a similar construction is arranged so that the surface of the anode may be in contact with the atmosphere inside the case and the surface of the cathode may be in contact with the atmosphere outside the case and DC voltage' is applied between both the electrodes.

In a preferred embodiment, it is necessary to set the DC voltage to be applied between both the electrodes within a range generating no hydrogen from the cathode, concretely a range of 2 V to 3 V. A film made of fluororesin having an amino group can be used for the anion exchanger polymer electrolyte and a porous thin film made of platinum is preferably used for the anode and for the cathode.

Embodiments of the present invention will now be described, by way of example, with reference to the accompanying drawings, in which:

Fig. 1 is a sectional view showing a working condition of the conventional air conditioning method;

Fig. 2 is a sectional view showing a working condition of a preferred embodiment according to the present invention; and

Fig. 3 is a sectional view showing a working condition of another preferred embodiment according to the present invention.

Fig. 2 shows a working condition of a preferred embodiment according to the present invention. Referring to Fig. 2, reference numeral 6 designates a case to be air conditioned. The case 6 is provided with a cell 20 having an anode 12, a cathode 13 and an anion exchanger polymer electrolyte 11 sandwiched between both the electrodes 12, 13 so that the cell 20 extends through a wall of the case 6. A surface of the cathode 13 is in contact with an ambient atmosphere 7 inside the case 6 while a surface of the anode 12 is in contact with an atmospheric air 8 which is an atmosphere outside the case 6. The anion exchanger polymer electrolyte 11 is formed of a film made of fluororesin having an amino group and both the anode 12 and the cathode 13 are formed of a porous thin film made of platinum. The anode 12 and the cathode 13 are connected to a DC power source 4 through lead wires 5 and DC voltage within a range bringing about no generation of hydrogen from the cathode 13, concretely a range of 2 V to 3 V, is applied between both the electrodes 12, 13.

Next, the operation is described.

A reaction expressed by the following equation (3) occurs between steam and oxygen in the ambient atmosphere 7 inside the case 6 on the cathode 13.

$$2H_2O + O_2 + 4e^- \rightarrow 4OH^- \quad (3)$$

Hydroxide ions formed by this reaction are transferred from the cathode 13 toward the anode 12 through the anion exchanger polymer electrolyte 11. A reaction expressed by the following equation (4) occurs on the anode 12.

$$4OH^- \rightarrow 2H\,O + O_2 + 4e^-$$

As a result, water (steam) and oxygen are decomposed on the side of the cathode 13, that is, the side of the ambient atmosphere 7, while water and oxygen are formed on the side of the anode 12, that is, the side of the atmospheric air 8. As a whole, steam and oxygen in the ambient atmosphere 7 are transferred to the atmospheric air 8 through the cell 20.

Accordingly, in this first preferred embodiment the humidity and the oxygen-concentration within the case 6 can be simultaneously reduced. As a result, for example where electronic instruments are housed in the case 6, steam and oxygen leading to corrosion can be simultaneously reduced, so that the progress of corrosion can be suppressed.

Fig. 3 shows a working condition of another preferred embodiment according to the present invention. Referring to Fig. 3, the same reference numerals designate the same parts as in Fig. 2. In this embodiment the surface of the anode 12 is in contact with the ambient atmosphere 7 inside the case 6 while the surface of the cathode 13 is in contact with the atmospheric air 8.

Next, the operation is described.

The reaction expressed by the above described equation (3) occurs between steam and oxygen in the atmospheric air 8 on the cathode 13 and the resulting hydroxide ions are transferred from the cathode 13 toward the anode 12 through the anion exchanger polymer electrolyte 11. The reaction expressed by the above-described equation (4) occurs on the anode 12. As a whole, steam and oxygen in the atmospheric air 8 are transferred to the ambient atmosphere 7 inside the case 6 through the cell 20.

Accordingly, in this second preferred embodiment the humidity and the oxygen-concentration within the case 6 can be simultaneously increased. As a result, the accelerated corrosion test for electronic instrument and the like housed in the case 6 can be easily carried out.

As the present invention may be embodied in several forms without departing from the essential characteristics thereof, the present embodiments are therefore illustrative and not restrictive. All changes that fall within the meets and bounds of the claims, or equivalents of such meets and bounds thereof are therefore intended to be embraced by the claims.

Claims

1. An air conditioning method for reducing humidity and oxygen-concentration within an enclosure (6),

comprising:
arranging a cell (20) having an anode (12), a cathode (13) and an anion exchanger polymer electrolyte (11) sandwiched therebetween so that a surface of said anode is in contact with an atmosphere (8) outside said enclosure and a surface of said cathode is in contact with an atmosphere (7) inside said enclosure; and
applying DC voltage (4) between said anode and said cathode.

2. An air conditioning method for increasing a humidity and an oxygen-concentration within an enclosure, comprising;
arranging a cell (20) having an anode, (12), a cathode (13) and an anion exchanger polymer electrolyte (11) sandwiched therebetween so that a surface of said anode is in contact with an atmosphere (7) inside said enclosure and a surface of said cathode is in contact with an atmosphere (8) outside said enclosure; and
applying DC voltage (4) between said anode and said cathode.

3. An air conditioning method as set forth in Claim 1 or 2 wherein said DC voltage is set within a range bringing about no generation of hydrogen from said cathode.

4. An air conditioning method as set forth in any preceding claim, wherein said DC voltage is set at a range of 2 V to 3 V.

5. An air conditioning apparatus for reducing a humidity and oxygen-concentration within an enclosure, comprising;
a cell (20) which has an anode (12), a cathode (13) and an anion exchanger polymer electrolyte (11) sandwiched therebetween for arrangement so that a surface of said anode (12) is in contact with an atmosphere (8) outside said enclosure and a surface of said cathode (13) is in contact with an atmosphere (7) inside said enclosure; and
means (4) for applying DC voltage between said anode and said cathode.

6. An air conditioning apparatus for increasing a humidity and an oxygen-concentration within an enclosure, comprising;
a cell (20) which has an anode (12), a cathode (13) and an anion exchanger polymer electrolyte (11) sandwiched therebetween for arrangement so that a surface of said anode (12) is in contact with an atmosphere (7) inside said enclosure and a surface of said cathode (13) is in contact with an atmosphere (8) outside said enclosure; and
means (4) for applying DC voltage between said anode and said cathode.

7. An air conditioning apparatus as set forth in Claim 5 or 6 wherein said anion exchanger polymer electrolyte (11) is formed of a film made of a fluororesin having an amino group.

Claim 5 , 6 or 7, wherein said cathode (13) is formed of a porous thin film made of platinum.

9. An air conditioning apparatus as set forth in Claim 5, 6, 7 or 8, wherein said anode (12) is formed of a porous thin film made of platinum.

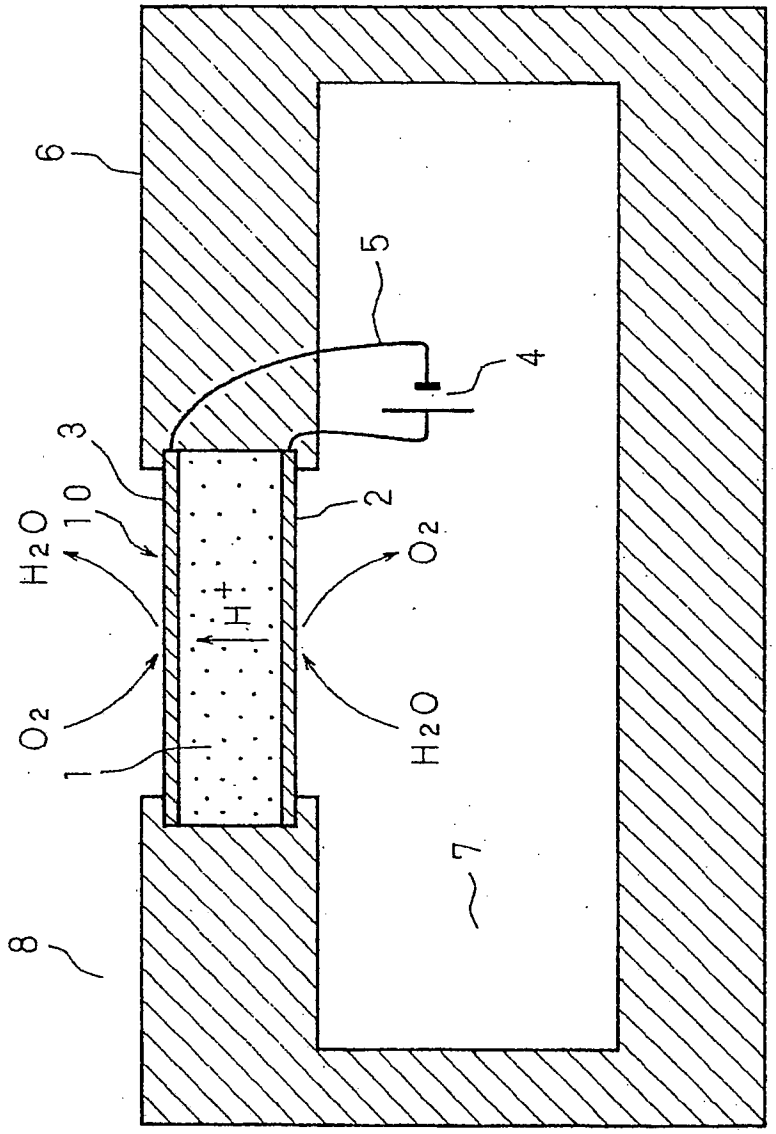

Fig. 1
Prior Art

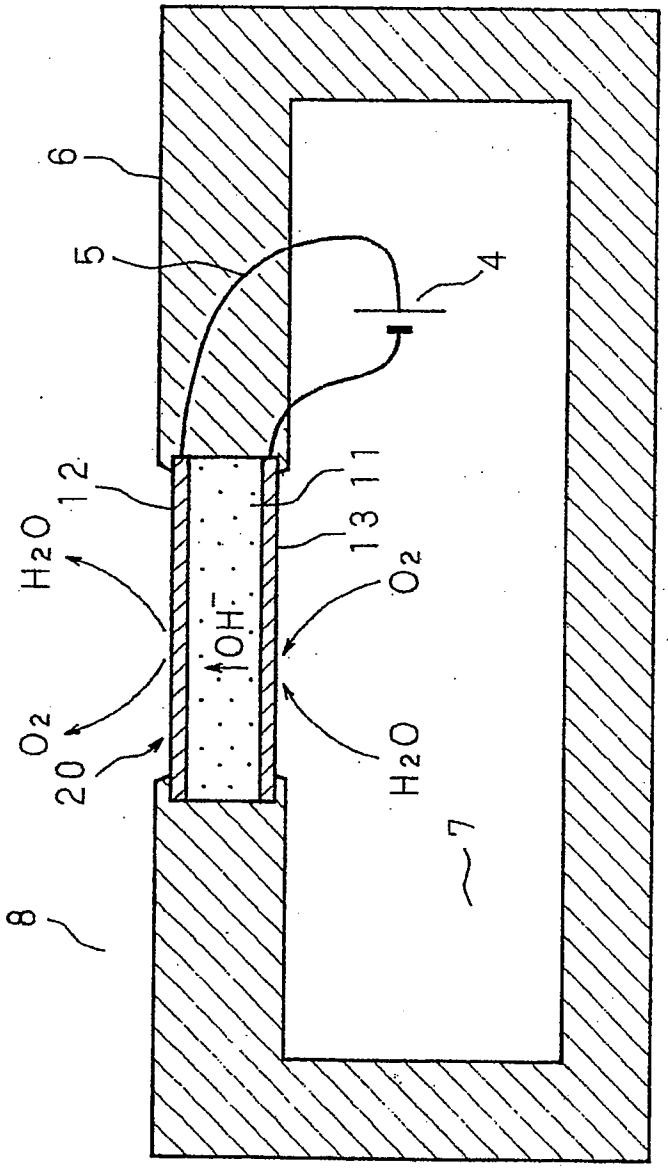

Fig. 2

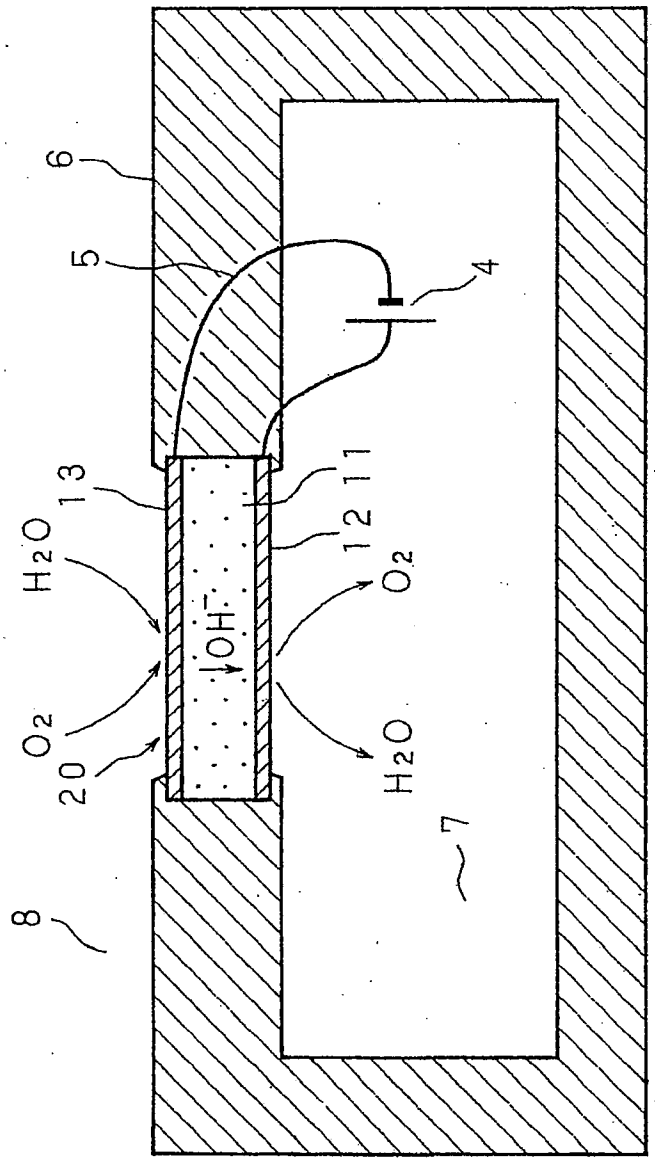

Fig. 3

European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 90 31 2488

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
A	EP-A-0 313 658 (MITSUBISHI) * Claims 1-13 *	1-9	B 01 D 53/26
A	EP-A-0 295 054 (MITSUBISHI) * Claims 1-11 *	1-9	

TECHNICAL FIELDS SEARCHED (Int. Cl.5)

B 01 D

The present search report has been drawn up for all claims

Place of search	Date of completion of search	Examiner
The Hague	08 February 91	KANOLDT W.W.

CATEGORY OF CITED DOCUMENTS

X: particularly relevant if taken alone
Y: particularly relevant if combined with another document of the same catagory
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